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(54) Liquid mulch.

(57) A liquid mulch for providing a protective crust comprises an aqueous composition comprising:

a polymeric binder; and

per 100 parts by weight of said binder, about 100 to about 1600 parts by weight of suitable particulate filler; said aqueous composition having a solids level of not less than about 30 (optionally about 30 to about 85) per cent by weight. The liquid mulch can be applied to a domain (e.g. an agricultural domain) so as to provide a dry coat weight of about 33.5 to 1674 g/m^2. Crop production can be enhanced by said application.

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LIQUID MULCH

The present invention relates to a liquid mulch for various purposes. Crop production may be enhanced in e.g. up to four ways by the liquid mulch. Thus, the liquid mulch may enhance production by providing at least one of: increased plant population, increased yield, a reduced time to plant maturity, and an increased survival rate through decreased stress on plants. Any method of increasing crop production is valuable to the agricultural, horticultural, or reforestation industries. A method of decreasing the time to crop maturation is of significant interest to fresh produce farmers as it provides earlier crops which may often be sold at a premium price. It also permits staggering the receipt of harvested crops over a longer period of time. The staggering of crops permits food processing plants to have a more uniform production. In areas where successive crops are grown during the year, decreasing the period of time to harvest may permit the planting of an additional crop further increasing the total production from the land under cultivation. In horticultural industries this results in a shorter time for trays of plants to be ready for marketing. This will increase green house yields for decorative plants, potted plants and vegetables for transplanting.

In the production of vegetables, there has been an increasing trend to use plastic film mulch. This mulch helps keep weeds down, reduces the leaching of minerals from the soil, retains moisture, warms the soil and in some cases helps retain volatile fumigants applied to the soil prior to planting. Some plastic mulches are promoted as photodegradable. This usually involves incorporating a photo-degradable component in the plastic. It is difficult to compound the plastic so that the mulch

maintains its integrity substantially throughout the growing system and then rapidly degrades as the crop ripens. It is also extremely difficult to estimate the weathering conditions the plastic will be exposed to in any given year. Most plastic mulches have to be removed from the fields prior to preparing for the next crop. This removal is a labour and energy intensive job. The removal cost is relatively high, about £ 125-150 per acre (0.4 Hectare). Plastic not removed may cause problems in further use of the fields.

In applying a plastic mulch it is not possible to change application weights and widths "on the fly", and the edge of the mulch must be buried in the soil to hold the mulch in place. The plastic mulch system requires special equipment, is relatively inflexible, and permits only about 75% of the plastic being effectively used, and must be laid tight to prevent flapping in the wind.

A liquid mulch of the present invention can be provided to enable various advantages, e.g. to overcome the above drawbacks of the plastic mulch system.

A first aspect of the present invention provides a liquid mulch for providing a protective crust under the conditions of use, said liquid mulch being characterised by being an aqueous composition comprising:
a polymeric binder; and
per 100 parts by weight of said binder, about 100 to about 1600 parts by weight of suitable particulate filler;
said aqueous composition having a solids level of not less than about 30 (optionally about 30 to about 85) per cent by weight.

A second aspect of the present invention provides a process for applying a liquid mulch to a domain, characterised by said application comprises

applying (optionally by spraying) at least one liquid mulch of the first aspect of the present invention.

The liquid mulch is easily applied to any suitable domain (e.g. an agricultural domain). The mulch may be applied by spraying, so that it is applied only as required, and the coat weight may be readily adjusted, and the mulch may be applied simultaneously with seeding or transplanting. The liquid mulch forms a protective crust at the domain, e.g. a friable crust which is readily broken by mechanical action. Thus, a field only need be ploughed and/or harrowed in preparation for the next planting. Generally, the protective crust provided by the present invention has sufficient integrity to help reduce evaporation yet have sufficient porosity to permit water or post applied fertilizer top dressing (particular nitrogen dressing) to enter the soil, especially during the later stages of plant development. The liquid mulch permits the incorporation of e.g. a

broader range of herbicides, insecticides, fungicides, and nematicides than those which may be incorporated into plastic mulch as such agents must be capable of withstanding extrusion temperatures of about 250°C.

As an added benefit, the present invention helps reduce soil erosion and the leaching of fertilizer due to wind and water. This helps reduce losses of young plants in heavy rains or high winds.

United States Patent 2,961,799, issued November 29, 1960, to Alco Oil and Chemical Corporation discloses a method for treating soil to prevent erosion. The method involves applying to the soil a composition comprising about 0.5 to 5, preferably about 2 to 4, weight per cent of a water insoluble rubber and 0.005 to 0.5, preferably about 0.05 to 0.15 weight per cent of a counter penetrant at a prescribed rate. The counter penetrant is used to prevent the composition significantly penetrating the top layer of soil. The mulch of the present invention contains a significantly higher solids level than that in the Arco patent. Such a mulch may not penetrate the soil but rapidly dry to form a crust on the soil surface.

British Patent 1,007,671, issued October 22, 1965, to The International Synthetic Rubber Company Limited discloses a process for controlling soil erosion. The process comprises applying to a soil a latex of an oil extended rubber. The rubber latex may be extended with from 50 to 1000 parts by weight of oil per 100 parts by weight of rubber. The latex is applied at a rate to provide from about 40 to 300 grams of oil extended rubber per square meter. The latex is applied at a solids content of from about 5 to 30 per cent. The mulch of the present invention may be used at a much higher solids content, namely in the 30 to 85 per cent total

solids range.

British Patent 1,007,671

is primarily concerned with prevention of soil erosion.

British Patent 1,053,870, issued January 4, 1967, to The International Synthetic Rubber Company also deals with methods to prevent soil erosion. The surface of the soil is treated with rubber which has been extended with oil or bitumen or both. The bitumen helps reduce the cost of the treatment. The cost of oil has risen dramatically in the 1970's which tends to make the extending of rubber with oil less economicaly feasible for the application of rubbery emulsions to reduce soil erosion. The cost of bitumen has also increased in the 1970's making the use of latices extended with bitumen less economically feasible for the prevention of soil erosion.

Neither of the International Synthetic Rubber Company patents contemplates the high loading of particulate filler as required in the present invention. As noted above the filler loadings used in the present invention contribute to the formation of a crust on the agricultural domain.

In the present invention, the mulch may be applied to an agricultural domain to enhance crop yield. The binder need not form a continuous impermeable film. In fact, it may be desirable to apply a latex compound which forms a permeable crust.

There are a number of theories concerning factors which affect plant growth. Germination tends to require temperatures in excess of 12.8°C.Photosynthesis takes place at a relatively rapid rate at temperatures in the range from 10 to 35°C, with faster rates at higher temperatures. The transpiration of a plant is affected by the atmospheric temperature at the leaves and the soil temperature. The present invention may be used to increase the soil temperature and the temperature above the soil. These increases in temperature should increase photosynthesis rate which should promote plant growth. The temperature increase should also increase transpiration rates in plants. It is believed that such increases should increase the water uptake of a plant and possibly increase the uptake of nutrients from the soil, in effect "force feeding" the plant.

As used on this specification , domain or agricultural domain is intended to be given a broad interpretation including, trays of flowers or vegetables grown in greenhouses, fields such as in growing cereals including corn and wheat and in vegetable and fruit farms, outdoor nurseries for trees, shrubs and plants, sod farms, and reforestation projects.

The phase capable of forming a protective crust under the conditions of use means that when the mulch is applied to any domain, the mulch will dry to a crust which will withstand normal weather conditions expected for the time period the crust will remain in place. These conditions and times may vary widely from a short period of about a month in a green house to a growing season on a farm field, to several years in a

forest, vineyard or orchard. The capability of forming a protective crust under the conditions of use in most instances may be fairly simply tested. A sample liquid mulch is applied to the soil at the desired dry coat weight and allowed to dry to form a crust. The crust is then sprinkled with an amount of water sufficient to approximate a heavy rain. The crust should not break up under these conditions. After the crust is dry it should crumble when lightly rubbed between the thumbs and forefingers.

Polymeric binders used in accordance with the present invention must be capable of forming a crust with the other ingredients in the mulch and the soil surface. Generally, the mulch should be film forming under the conditions of use. Preferably, the polymer should have a glass transition temperature (Tg) of less than about 35°C, most preferably the Tg of the polymer is less than about 20°C. It is possible to compound a polymer having a Tg greater than about 35°C with plasticizers so that the resulting mulch would be capable of forming a protective crust under the conditions of use.

In the practice of the present invention, it is desirable to formulate the mulch to have no, or a minimum, detrimental effect on the environment. In considering this desideratum one must take into account the facts that the components in the mulch , and the mulch per se will be left in an/or at the domain and that the domain may be subject to multiple treatments according to the present invention. In selecting ingredients one should consider available information and scientific opinion concerning the effect of each ingredient in the mulch and their residues on the environment.

There are a great many types or families of polymers which may be used in accordance with the present invention. The length of time the crust is to remain in place will influence the selection of polymer. Generally rubbery polymers are suitable for use in the present invention. This includes natural rubber, chloroprene, polyisoprene and synthetic rubber.

One synthetic rubber is a polymer consisting primarily of soft monomer such as C_{4-6} conjugated diolefins and a hard monomer such as C_{8-12} vinyl aromatic monomers or a C_{2-8} alkenyl nitrile. Generally, the C_{4-6} conjugated diolefin is present in an amount from about 20 to 80 weight per cent of the polymer, preferably from about 80 to 30, most preferably from about 40 to 80 weight per cent of the polymer. The C_{8-12} vinyl aromatic monomer is generally present in the polymer in an amount from about 80 to 20 weight per cent of the polymer, preferably from about 20 to 70, most preferably from about 20 to 60 weight per cent of the polymer. Some C_{8-12} vinyl aromatic monomers may be unsubstituted or substituted by a C_{1-4} alkyl radical or a chlorine or bromine atom.

Some C_{4-6} conjugated diolefins are butadiene and isoprene. Some C_{8-12} vinyl aromatic monomers are styrene, alpha-methyl styrene, tertiary-butyl styrene, chlorostyrene, bromostyrene.

A synthetic rubber may also contain a monomer having a functional group. The monomer containing a functional group may be present in an amount from about 0.5 to 10 weight per cent of the polymer, preferably from about 0.5 to 5 weight per cent. The monomer having a functional group may be an acid, an ester, an aldehyde or an amide. Some acid monomers are C_{3-9} ethylenically unsaturated carboxylic acids. Some

ester monomers are C_{1-8} alkyl or C_{1-8} alkanol esters of C_{3-9} ethylenically unsaturated carboxylic acids. Some aldehyde monomers are C_{3-9} ethylenically unsaturated aldehydes. Some amides are amides of C_{3-9} ethylenically unsaturated acids, which may be unsubstitued or substituted at the nitrogen atom by up to two C_{1-4} alkyl or alkanol radicals.

Typical monomers containing functional groups are acrylic acid, methacrylic acid, fumaric acid, itaconic acid, cinnamic, citraconic acid, maleic acid, methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, hydroxyethyl acrylate, hydroxyethyl methacrylate, ethylhexyl acrylate, ethylhexyl methacrylate, acrylamide, N-methyl acrylamide, N-ethyl acrylamide, methacrylamide, N-methyl methacrylamide, N-ethyl methacrylamide, N-methylol acrylamide, N-methylol methacrylamide, acrolein, methacrolein, and cinnamaldehyde.

In the foregoing polymers, up to about 40 weight per cent of the C_{8-12} vinyl aromatic monomer may be replaced by a C_{3-9} alkenyl nitrile. The most common alkenyl nitrile is acrylonitrile.

Nitrile rubber polymers per se may also be used in accordance with the present invention. These polymers comprise from about 5 to about 35 weight per cent of a C_{2-8} alkenyl nitrile, preferably acrylonitrile, and from about 95 to about 65 weight per cent of a C_{4-6} conjugated diolefin. The nitrile rubber may also contain up to about 10 weight per cent of a monomer which contains a functional group. Some monomers which contain functional groups have been listed above.

Polymeric binders useful in accordance with the present invention may be polymers of olefins and alkenyl or alkenol esters of C_{1-8} saturated carboxylic acids. Some polymers comprise from about 1 to about 40 weight

per cent of at least one C_{2-4} mono-olefin and from about 99 to 60 weight per cent of a C_{2-8} alkenyl or alkenol ester of a C_{1-8} saturated carboxylic acid. Some mono-olefins are ethylene and propylene. The most common C_{2-8} alkenyl or alkenol ester of a C_{1-8} saturated carboxylic acid is vinyl acetate. Optionally, the polymers may also contain from about 0.5 to 5 weight per cent of a monomer containing a functional group as described above.

The polymeric binder may be polymer of an C_{2-3} olefin and an C_{1-8} alkyl or C_{1-8} alkanol ester of a C_{3-9} ethylenically unsaturated C_{3-9} carboxylic acid. The olefin may be present in an amount from about 1 to about 40 weight per cent. The alkyl or alkanol ester of a C_{3-9} ethylenically unsaturated carboxylic acid may be present in an amount from about 99 to about 60 weight per cent. Optionally the polymer may contain from about 0.5 to 10 weight per cent of a monomer having a functional group. Some olefins, esters and monomers having a functional group have been discussed above.

The polymer may be a functional olefin. The polymer may comprise from about 10 to about 20 weight per cent of a monomer containing a functional group preferably acrylic or methacrylic acid and the balance a C_{2-3} olefin.

The polymeric binder may be an acrylic type binder. Such polymers may consist of from about 60 to about 99.5 weight per cent of a C_{1-8} alkyl or alkanol ester of acrylic or methacrylic acid and from about 0.5 to 40 weight per cent of a C_{3-8} ethylenically unsaturated carboxylic acid. Some ethylenically saturated carboxylic acids have been listed above.

Some polymers which may be used in accordance with the present invention are polyvinyl chloride,

ethylene-propylene copolymers, butyl rubber, copolymers of ethylene, propylene and a conjugated diene monomer, polysulfides (such as the condensation product of a C_{2-4} olefin dichloride with sodium polydisulfide), polybutadiene.

Many of the above polymers may be prepared by free radical emulsion polymeriation processes. Usually the resulting latices are anionic or non ionic. The polymers may in some cases be prepared as cationic emulsions. Polymers which have not been prepared in an aqueous emulsion may be converted to a latex by techniques well known in the art. Organic solutions or dispersion of a polymer may be emulsified in water and the organic phase may then be driven off.

Depending on the type of polymer and the properties sought in the crust, the molecular weight and molecular weight distribution of the polymer may be controlled. Methods for controlling the molecular weight and molecular weight distribution of many emulsion polymers are well known and involve the use of "modifiers" such as carbon tetrachloride or an alkyl mercaptan.

The aqueous polymer dispersion is compounded with from about 100 to about 1600 parts by weight of a particulate filler. As the compound is generally intended to be applied as a spray, the filler should be of a sufficiently small size to pass through a spray nozzle. The filler should not be fibrous, that is, having a length substantially greater than its diameter. Some compounding ingredients are the fillers and pigments commonly used in the latex compounding. The filler may be finely divided matter of organic origin such as wood flour, sawdust, cellulose, starch, lignosulfonate, lignin, or very finely divided vegetable matter, or particulate organic waste, or a mixture thereof. The filler may be an inorganic material such as calcium carbonate, clay,

stonedust, limestone, carbon black or micaflakes, or a mixture thereof. The micaflakes preferably should have a high aspect ratio. Such mica causes sunlight to be reflected which is believed to give a degree of insect control as well as cooling the soil in hotter climates. Preferably, the filler is used in an amount from about 300 to 800 parts by weight per 100 parts by dry weight of polymer. Depending upon the climate during the growing season the colour of the mulch may be selected to provide an increased benefit. Black mulches provide maximum opacity. White mulches provide cooler root temperature. Silver mulches provide maximum cooling. Transparent mulches allow maximum radiation to pass into the soil and may help soil sterilization. In cooler climates the mulch preferably contains sufficient carbon black to make the resulting film heat absorbing. Generally the carbon black is not required in amounts in excess of about 5 parts by weight per 100 parts by dry weight of polymer, preferably in the range from about 1 to 3 parts by weight per 100 parts by weight of polymer. This dark coloured layer by increasing the soil temperature helps the seeds to germinate faster and promotes more vigorous early growth. In hot climates where soil baking tends to be a problem the mulch should be heat reflective, preferably white. Under these conditions, the preferred filler would be calcium carbonate or slaked lime, possibly in conjunction with a pigment such as titanium dioxide to increase opacity and whiteness. Transparent mulches may be prepared by selecting a filler having a refractive index substantially the same as the refractive index of the polymer. The foregoing illustrates general principles and it must be kept in mind that mixtures of different types of fillers and pigments are contemplated by the present invention.

In preparing the mulch a surfactant may be required to ensure that the filler is well dispersed and the mulch has sufficent mechanical stability for spraying. The amount of surfactant required will depend on the efficiency of the surfactant. The surfactant may be a soap of a long chain fatty acid or oil such as stearic, palmitic or rosin acid/soaps. The surfactant may be synthetic such as the commercially available sulfate, sulfonate and phosphate derivatives of alkyl, or alkyl aryl, hydrocarbons or the condensation products of polyalkylene glycols and alkyl or alkyl aryl hydrocarbons. (Commercially available surfactants are listed in the annual text Detergents and Emulsions by McCutcheon's). The charge on the surfactant should be compatible with the charge on the dispersion of polymeric binder. The compatibility of the surfactant and the polymeric dispersion can be simply tested by mixing a small sample of dispersion with surfactant and seeing if the dispersion is destabilized.

The amount of surfactant required will generally be in the range from about 0.5 to about 10 parts of weight per 100 parts by dry weight of polymer. The amount of surfactant required to stabilize the mulch may be readily determined by routine experiments. In preparing the mulch of the present invention, care should be taken to avoid localized destabilization. For carboxylated latices, it is preferable to add the filler dry. For less stable latices, the filler may have to be added as a paste or dispersion.

The mulch may optionally contain a dispersing agent. The dispersing agent may be used in amounts up to about 5 parts, preferably not greater than about 1 to 2 parts by weight per 100 parts by weight of polymeric binder. There are many dispersing agents available. One

suitable type of dispersing agent comprises polyphosphates. The total amount of surfactant and dispersing agent should be kept to a minimum to minimize the rewetting of the protective crust and consequent loss of strength.

The mulch is generally prepared to a solids content of from about 30 to 85 weight per cent, preferably from about 50 to 85 weight per cent. If desired, the mulch may be subsequently diluted with water but this will require a higher application rate or multiple passes to achieve the required coat weight. Desirably the mulch is used at not less than about 30 weight per cent solids, most preferable not less than 50 weight per cent solids.

The mulch may contain additional ingredients used in the agricultural industry. The mulch may contain small amounts of viscosity control agents to provide a viscosity of about 1000 cps thus preventing the filler from settling out. Some thickeners are the natural thickeners such as guar gum, gum tragcanth, gum arabic, carrageenin, starch, pectin, cellulose, modified thickeners such as carboxymethyl cellulose and synthetic thickeners such as sodium polyacrylates.

The mulch may also contain other agents to enhance crop production e.g. fertilizers, herbicides, fungicides, insecticides, nematicides and plant nutrients such as trace amounts of mineral salts containing one or more of sodium, manganese zinc, copper, iron, potassium, lithium, magnesium, boron, iodine, cobalt, molybdenum, silicon, fluorine, aluminium, nickel, selenium, and sulphur. Organic compounds, biostimulants and natural growth promoters such as yeast, auxentriolic acid, auxenolonic acid, indole acetic acid, naphtholine acetric acid, and auxin lactose may also be included in the mulch.

The mulch could also contain small amounts of bacteria capable of producing nitrogen in the soil such as Azobacter and Adostridium posteuranium, and B. Radicicola. The amount of such growth enhancing materials in the total mulch will be very low and should not cause instability in the mulch .

If fertilizers, herbicides, nematicides, fungicides or insecticides are incorporated into the mulch they will generally be used in fairly low amounts, usually not more than about 10 parts by weight, preferably in the range from about 1 to 4 parts by weight per 100 parts by weight of polymeric binder. Water soluble herbicides, insecticides, nematicides, fungicides, fertilizers or other growth stimulants are readily incorporated into the mulch . Care should be taken to avoid destabilization of the mulch which could lead to spraying problems. Hydrophobic fertilizers, herbicides, insecticides, nematicides, fungicides or plant growth stimulating agent may be prepared as oil in water emulsions, which may be added to the mulch of the present invention.

As noted above, the present invention provides greater flexibility in incorporating fertilizers, herbicides, insecticides, nematicides, fungicides and growth stimulating agents as they are not subjected to the extrusion temperatures required in the manufacture of plastic sheet mulch.

Our mulch may be applied to a prepared field or unprepared terrain when employed in reforestation applications. Depending on the crop, the preparation may be as simple as harrowing the field. In high value vegetable and small fruit farming, the preparation tends to be more intensive. The field may be formed into raised beds in rows and a fumigant may be applied to the soil.

The mulch may be applied following fumigation. Preferably the soil is very lightly rolled to smooth and slightly compact the soil surface prior to applying the mulch. If desired the crop may be seeded or transplants set in place prior to application of the mulch. If required, guards may be placed on the spray applicator to prevent the latex from being applied where the seeds are sown. It is also possible to seed or transplant the crop subsequent to application of the mulch. In this case the seed could be pregerminated if desired. The equipment to apply the mulch will depend on the size of the area under cultivation. For the backyard gardener, greenhouse use, or for reforestation, a simple hand held sprayer will suffice. Liquid mulch according to the present invention may be sold to apartment or indoor gardeners in aerosol or pump spray containers. For the commercial vegetable farmer conventionally available spray equipment with multispray capabilities and interchangeable tip capabilities is preferred. To minimize labour various pieces of farm equipment may be used in tandem. Thus a fumigent applicator, bed shaper, roller, planter, and sprayer could be used in tandem to provide a one pass planting, with a reduction in planting costs.

The mulch may be applied to provide a dry coat weight of 0.1 to 5.0 (e.g. 0.25 to 1.0) oz/ft^2 - 33.5 to 1674 (e.g. 83.7 to 334.8) g/m^2 or thereabouts as some examples. The mulch should dry to form a crust on the surface of the soil. At the low coat weight it may be desirable to apply the mulch in a foamed state to control the application rate of mulch. The use of foamed compound in textile applications is well known and disclosed in Canadian Patents 794,319 and 876,069 issued September 10, 1968 and July 20, 1971 respectively to Polymer Corporation.

In cases where it is desired to form a more impermeable film of mulch, it is possible to apply two or more coats.

As noted above, commercially available spray equipment may be used to apply the liquid mulch. For some applications, such as transplant trays for vegetables or bedding plants or even corn fields, it may be preferable to spray the entire respective domain. In other applications, such as reforestation projects, the spray may be applied in an area of about 6 to about 60 (preferably about 18 to about 24) inches (about 15.24 to about 152.4 - preferably about 45.7 to about 70 - cm) around the base of a transplanted tree. In truck farming, the mulch may be applied in strips down the field or raised beds; depending on the type of crop and the requirements of the equipment, these strips may be anywhere from about 6 to 60 inches (about 15.24 to about 152.4 cm) or the width of the spray equipment. By closing nozzles, or in more sophisticated equipment moving guards, the area of spray application may be divided into strips or bands. Generally for tomatoes and similar vegetables or fruits, the strips should extend from about 6 to about 60 (preferably about 12 to about 18) inches (about 15.24 to about 152.4 - preferably about 30.5 to about 45.7 - cm) on each side of a row of plants.

The following are examples of some particular embodiments of components in the liquid mulch.

The polymeric binder can comprise a latex of a polymer comprising about 20 to about 80 weight per cent of a C_{4-6} conjugated diolefin, from about 80 to about 20 weight per cent of a mixture comprising from about 100 to about 60 weight per cent of a C_{8-12} vinyl aromatic monomer which may be unsubstituted or substituted by a C_{1-4} alkyl radical or a chlorine or bromine atom, and up to about 40 weight per cent of a C_{3-9} alkenyl nitrile.

Said polymer may further comprise from about 0.5 to about 10 weight per cent of one or more monomers selected from:

(i) C_{3-9} ethylenically unsaturated carboxylic acids or C_{1-8} alkyl or C_{1-8} alkanol esters thereof;

(ii) C_{3-9} ethylenically unsaturated aldehydes;

(iii) amides of C_{3-9} ethylenically unsaturated acids which may be unsubstituted or substituted at the nitrogen atom by up to two C_{1-4} alkyl or C_{1-4} alkanol radicals.

The polymeric binder can comprise a latex of a polymer of from about 1 to about 40 weight per cent of at least one C_{2-4} mono olefin, and from about 99 to about 60 weight per cent of a C_{2-8} alkenyl or alkenol ester of a C_{1-8} saturated carboxylic acid. Said polymer may further comprise from about 0.5 to about 5 weight per cent of one or more monomers selected from:

(i) C_{3-9} ethylenically unsaturated carboxylic acids or C_{1-8} alkyl or C_{1-8} alkanol esters thereof;

(ii) C_{3-9} ethylenically unsaturated aldehydes;

(iii) amides of C_{3-9} ethylenically unsaturated acids which may be unsubstituted or substituted at the nitrogen atom by up to two C_{1-4} alkyl or C_{1-4} alkanol radicals.

The polymeric binder can comprise a latex of a polymer comprising from about 60 to about 99.5 weight per cent of a C_{1-8} alkyl or alkanol ester of acrylic or methacrylic acid, and from about 0.5 to about 40 weight per cent of a C_{3-8} ethylenically unsaturated carboxylic acid.

The present invention is illustrated but not restricted by the following Examples.

EXAMPLES

In the Examples, a field at Port Lambton, Ontario, was prepared by ploughing and harrowing. A series of strips 20 feet (6.1 metres) long were treated as follows:

(a) No treatment (control)

(b) Covered with a plastic sheet ; and

(c) Sprayed with mulch at an application rate of

(i) 0.7 oz/ft^2,24 in wide(234.4 g/m^2, 70cm)

The mulch was formulated as follows, on a dry weight basis

Latex A (a carboxylated SBR latex)	100 parts
Surfactant	0.5
Dispersant	1.25
Calcium carbonate	300

Water to 50 per cent solids.

Carbon black to provide a black or dark grey colour 1-2 parts

Viscosity control agent - to provide a viscosity of 1000 cps. to prevent filler settling out of the mulch.

The mulch was stable and did not suffer filler settling out and was applied using a hand sprayer. After the mulch dried, transplanted tomato plants were planted in the control plastic sheet , and domains treated in accordance with the present invention.

The domains were sprayed on June 1, 1984 by July 20 the growth on the areas treated in accordance with the present invention was superior to the control areas and comparable to the domains treated with plastic sheet. The domains treated in accordance with the present invention had a darker surface than areas treated with plastic sheet. The mulch applied in accordance with the present invention did not form a continuous film. Rather, the surface crust may break open in a manner similar to mud cracking in a dried puddle or pond. After harvesting the yield from the various experimental plots with a liquid mulch applied at 0.7 oz./sq. foot dry weight (234.4 g/m^2) .

	PLASTIC SHEET	SPRAYED MULCH	BARE SOIL
Width of treated area, ins. (cm)	(91.4)36	(70) 24	-
Type of Plastic	Pre slit	-	-
Plant spacing, ins. (cm)	(30.5)12	(30.5)12	(30.5)12
No. of plants	40	40	40
No. alive 9 days after planting	35	36	20
Soil temp. 9 days after planting, °F (°C)	(35) 95	(37.8)100	(21.1)70
Fruit yield from 3 random plants* 80 days from planting, lb (Kg)	(5.6) 12.3	(6.1)13.5	(3.4)7.5
Total ripe fruit 80 days from planting, lb (Kg)	(58.1) 128	(56.3)124	(29)64
Days to first ripe pick	72	75	80

* Note Normally harvesting of this crop takes place about 90 days after planting. The yield from 3 random plants was a mixture of both green and ripe fruits. The plastic sheet and the spray mulch produced approximately the same amount of ripe fruit at about 80 days after planting. It is important to note that the rows treated with plastic sheet required a bed width of 91.4 cm. After harvest the areas treated in accordance with the present invention required no further treatment to remove the mulch . The crust was completely friable and normal cultivation returned the soil to substantially the condition prior to application of the mulch .. To the farmer this is a significant saving over the cost required for removing plastic sheet from the field which may range from about $100 to $150 per acre.

In a laboratory experiment 10"x10" trays were filled to a depth of from 1 1/2" to 1 1/4" with soil (i.e. 25.4x25.4cm ; 3.8 to 3.2 cm). Then each tray was planted with pregerminated tomato

seeds. The trays were then sprayed with two different mulches at various coat weights. Mulch formulation was as in example 1. In one case Latex A described above was used, in the other case another carboxylated SBR latex having a higher styrene content was used, (Latex B). The coating was applied at various weights. The trays were then placed in the open air on top of the research laboratories of Polysar Limited.

During this test program one of the most impressive things observed was the relatively luxuriant nature of growth rate for the seedlings in those two trays where spray mulch had been employed compared to the control. The differences were most impressive to see but difficult to describe. To aid in conveying these differences a "growth index" value is employed. It is derived by multiplying the approximate average height of the seedling in a given tray by the average diameter of the foliage umbrella, in centimeters. The values given appear to reasonably convey the relative differences in growth vigor. The explanation(s) for the increased vigor was improved heat and moisture retention.

On day 6, the temperature of the soil in the trays was measured. The air temperature at the time of measuring soil temperature was 31.7°C. The experiment had to be terminated due to an extremely severe wind and rain storm which removed some surface soil and exposed the roots of the plants in the control tray. No evidence of such soil loss observed in any of the trays treated in accordance with the present invention.

The results are recorded in the following table entitled "Emergence Studies".

EMERGENCE STUDIES - EFFECT OF COATING WEIGHT

NOTE: Temperature Profile is soil temperature 1" (2.54 cm) below the soil surface at 1 P.M., July 30, air temperature 89.2°F (31.8°C)

TRAY #	1	2	3	4	5	6	7	8	9	10
MULCH	CONTROL	----------LATEX A----------					---------LATEX B-------			
COATING - OZ/FT^2 G/M^2	NIL NIL	0.125 41.8	0.25 83.7	0.5 167.4	0.75 251.1	1.0 334.8	0.125 41.8	0.25 83.7	0.5 167.4	0.75 251.1
% EMERGENCE @ DAY 1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	6	3	6	11	3	6	3	6	3	3
6	8	11	42	53	25	28	31	42	25	22
7	25	14	50	58	39	33	39	47	28	33
8	25	17	56	58	42	33	39	50	31	33
9	25	20	56	67	44	33	39	50	42	36
10	25	22	61	67	44	36	39	53	42	39
14	36	28	67	67	50	36	39	56	50	42
21	36	28	67	67	50	39	39	56	50	42
GROWTH INDEX @ DAY 21	7	42	24	56	13	30	28	14	10	25
TEMPERATURE PROFILE °C °F	96.1 35.6	95.7 35.4	96.6 35.9	96.6 35.9	98.1 36.7	99.1 37.3	97.5 36.4	97.0 36.1	96.8 36	97.9 36.6

On August 21, 1984, a sample of the mulch prepared with Latex A was tested in La Salle, Michigan, for field sprayability. The mulch was evenly sprayed using a single spray tip in a 2 ft (61cm) wide path at a tractor speed of 0.5 mph. (0.8 Kmph). Dry coat weight was about 0.69 oz/ft^2(231.1 g/m^2). Tractor speed was that normally used to transplant tomatoes. The crust dried quickly and measurements were taken of the air temperature above the crust surface and in the soil at a 6" depth. (15.24cm). The results are as follows:

	Soil	Covered With Liquid Mulch
Air Temp., °F,(°C)	90 (32.2)	100 (37.8)
Soil Temp. at 6" °F (15.3cm,°C)	78 (25.6)	81 (27.2)

For the purposes of comparison, a series of experiments were conducted to compare the growth of pregerminated tomato seeds treated in accordance with the present invention and treated in accordance with British Patent 1,007,671 and United States Patent 2,961,799.

A series of 10"x10"x2.25" trays were filled with soil to a depth of about 2" (25.4x25.4x5.72; 5.1 cm) with commercial top soil. In each tray, 25 pregerminated tomato seeds were planted at a depth 0.37"(0.94cm). The trays were then treated in the following manner.

One tray was untreated. This serves as a control.

Two trays were treated in accordance with the present invention. The mulch was a retained sample from the mulch applied to the soil in a commercial manner using a single tip sprayer. The mulch was applied at a 50 per cent solids level to provide dry coat weights of 0.75 and 0.5 oz./foot^2.(251.1, 167.4 g/m^2). In a further comparative example, the solids level was diluted to 25 per cent.

A series of trays were treated in accordance with Example 10 of British Patent 1,007,671. Example 10 was selected as it was felt to be closest to the subject matter of the present invention in terms of solids content and pigment levels.

In all the examples in this series of experiments, the latex used was a carboxylated SBR latex commercially produced by Polysar Limited. The latex was extended with Sundex 890* oil. The oil was added to the latex as an oil in water emulsion prepared in accordance with the teaching from line 63 through line 75 at page 3 of the disclosure. Ionic stabilizer was not added to the oil in water emulsion. (* = Trademark.)

The mulch formula in parts by dry weight was as follows:

	Emulsion Solids	Dry Parts	
Latex	---	100	
Sundex 890 emulsion	(50%)	300	
Carbon black	(35%)	4	
Water	---	---	to 30% solids

The mulch was applied at a dry coat weight of 0.5 oz/ft^2(167.4g/m^2) and 0.1667 oz/ft^2(55.81 g/m^2). This later application was based on the rate of 1/4 imperial pint/yd^2(0.17L/m^2) specified in the example.) The dry coat weight corresponds to wet coat weights of 11.00 grams per tray and 33 grams per tray respectively.

A compound was prepared in accordance with the formulation given at lines 50 to 56 of Col. 11 of U.S. Patent 2,961,799. The compound was applied to three trays. The coat weights were 0.25 and 5.0 oz. of rubber per square yard, based on the minimum and maximum coat weights disclosed at line 8 of Col. 7 (7.78g, 155.5g).

application rates of 0.0278, 0.5556 oz/ft^2 (9.3, 186 g/m^2). The remaining tray was treated to provide a dry weight of 0.5 oz/ft^2(167.4 g/m^2).

When the trays were initially prepared, the coatings in accordance with the present invention dryed rapidly to form a crust. The coatings in accordance with the prior art had a much higher water content and the trays were extremely wet. The coating compositions had a greater tendancy to penetrate the soil.

The trays were placed on the roof of the Polysar Research Building at Sarnia, Ontario. The trays were placed out on August 30, 1984, and the following observations were made.

Colour indicates the darkness of the surface of the tray when the samples were put outside. The colour was judged on a scale of 1 to 10 with 10 being the darkest.

The Growth Index was calculated as described above.

When the plants were placed outdoors, it was towards the end of the growing season. The weather was cooler than normal and there were several severe thunderstorms. Generally, the emergence of the plants was low and the Growth Index was low.

COMPARATIVE EXAMPLES

TRAY #	1	2	3	3A	4	5	6	7	8
MULCH	CONTROL	INVENTION			UK 1,007,671		US 2,961,799		
COATING - OZ./FT^2 G/M^2	NIL	0.75 251.1	0.5 167.4	0.5 167.4	0.167 55.9	0.5 167.4	.0278 9.31	.5556 186	0.5 167.4
COLOUR	1	7	6	4	5	5	2	3	3
% EMERGENCE @ DAY 1	0	0	0	0	0	0	0	0	0
6	8	4	12	0	8	0	0	0	0
7	8	16	24	0	16	4	4	0	4
8	12	32	38	0	20	0	4	4	8
9	24	36	60	4	40	8	20	8	8
12	36	40	68	28	72	32	40	12	36
13	36	40	72	28	72	32	44	16	36
15	36	40	72	28	72	32	44	16	36
16	36	40	72	28	72	32	44	16	36
19	36	40	72	28	72	32	44	16	36
GROWTH INDEX @ DAY 21	4.1	6.3	6.1	3.0	2.5	<2.0	4.6	2.3	3.8

NOTE: DAY 1 - AUGUST 30, 1984.
TRAY 3A - COMPOUND SPRAYED AT 25.0 PER CENT SOLIDS.

On day 6, the soil temperature at the bottom of the trays was measured. The results are:

Tray No.	1	2	3	3A	4	5	6	7	8
Temp. (°F)	70	76	75	76	74	73	72	72	72
(°C)	21.1	24.4	23.9	24.4	23.3	22.8	22.2	22.2	22.2

Claims

1. A liquid mulch for providing a protective crust, said liquid mulch being characterised by being an aqueous composition comprising:
a polymeric binder; and
per 100 parts by weight of said binder, about 100 to about 1600 parts by weight of suitable particulate filler;
said aqueous composition having a solids level of not less than about 30 (optionally about 30 to about 85) per cent by weight.

2. A liquid mulch as claimed in claim 1, characterised by being sprayable.

3. A liquid mulch as claimed in claim 1 or 2, characterised by said binder comprises a latex of a polymer comprising about 20 to about 80 weight per cent of a C_{4-6} conjugated diolefin, from about 80 to 20 weight per cent of a mixture comprising from about 100 to about 60 weight per cent of a C_{8-12} vinyl aromatic monomer which may be unsubstituted or substituted by a C_{1-4} alkyl radical or a chlorine or bromine atom, and up to about 40 weight per cent of a C_{3-9} alkenyl nitrile.

4. A liquid mulch as claimed in claim 3, characterised by said binder further comprises about 0.5 to about 10 weight per cent of one or more monomers selected from:

(i) C_{3-9} ethylenically unsaturated carboxylic acids or C_{1-8} alkyl or C_{1-8} alkanol esters thereof;
(ii) C_{3-9} ethylenically unsaturated aldehydes;
(iii)amides of C_{3-9} ethylenically unsaturated acids which may be unsubstituted or substituted at the nitrogen atom by up to two C_{1-4} alkyl or C_{1-4} alkanol radicals.

5. A liquid mulch as claimed in claim 1 or 2, characterised by said binder comprises a latex of a polymer comprising about 1 to about 40 weight per cent of at least one C_{2-4} mono olefin, and from about 99 to about 60 weight per cent of a C_{2-8} alkenyl or alkenol ester of a C_{1-8} saturated carboxylic acid.

6. A liquid mulch as claimed in claim 5, characterised by said binder further comprises about 0.5 to about 5 weight per cent of one or more monomers selected from:

(i) C_{3-9} ethylenically unsaturated carboxylic acids or C_{1-8} alkyl or C_{1-8} alkanol esters thereof;
(ii) C_{3-9} ethylenically unsaturated aldehydes;
(iii)amides of C_{3-9} ethylenically unsaturated acids which may be unsubstituted or substituted at the nitrogen atom by up to two C_{1-4} alkyl or C_{1-4} alkanol radicals.

7. A liquid mulch as claimed in claim 1 or 2, characterised by said binder comprises a latex of a polymer comprising about 60 to about 99.5 weight per cent of a C_{1-8} alkyl or alkanol ester of acrylic or methacrylic acid, and from about 0.5 to about 40 weight per cent of a C_{3-8} ethylenically unsaturated carboxylic acid.

8. A liquid mulch as claimed in claim 1 or 2, characterised by said binder is selected from:

polyvinylchloride;
ethylene-propylene copolymers;
butyl rubber;
copolymers of ethylene, propylene, and a conjugated diene monomer;
polysulfides;
polybutadiene.

9. A liquid mulch as claimed in any one of claims 1 to 8, characterised by said binder has a T_g of less than about 35°C, optionally less than about 20°C.

10. A liquid mulch as claimed in any one of claims 1 to 9, characterised by said filler is selected from: wood flour, sawdust, cellulose, starch, lignosulfonate, lignin, finely divided particulate vegetable matter, particulate organic waste, calcium carbonate, clay, stonedust, limestone, carbon black, micaflakes, slaked lime, or any mixture therefrom.

11. A liquid mulch as claimed in any one of claims 1 to 10, characterised by further comprising at least one additive, optionally selected from: a water dispersible herbicide, a water dispersible pesticide, or any mixture therefrom.

12. A process for applying a liquid mulch to a domain, characterised by a liquid mulch as claimed in any one of claims 1 to 11 is applied to said domain so as to enable a protective crust to be provided.

13. A process as claimed in claim 12, characterised by said application provides a dry coat weight of about 33.5 to 1674 g/m^2 (0.1 to 5.0 oz/ft^2).

14. A process for enhancing crop production, characterised by said enhancement is enable by a process as claimed in claim 12 or 13.